

Remarks

Applicant and the undersigned would like to thank the Examiner for his efforts in the examination of this application. Reconsideration is respectfully requested.

I. Specification

The Examiner has objected to the Specification as referring to Claims 1, 6, and 8 on pages 1 and 5.

Paragraph [0004] has been deleted, and paragraph [0016] has been amended in order to remove these references.

This objection has thus been addressed, and the Specification is believed in compliance with the Examiner's requirements.

II. Rejection of Claims 4 and 5 under 35 USC 112

The Examiner has rejected Claims 4 and 5 under 35 USC 112, second paragraph, as being indefinite.

The Examiner has specifically cited the phrase "in particular" as rendering these claims indefinite.

Claims 4 and 5 have been amended to remove "in particular a catheter or stent" (Claim 4) and "in particular a vessel" (Claim 5), and these elements have been introduced into new Claims 12 and 13, dependent, respectively, from Claims 4 and 5.

Claims 4 and 5 are now believed to comply with 35 USC 112, second paragraph.

III. Rejection of Claims 1-3 and 5-10 under 35 USC 102(b)

The Examiner has rejected Claims 1-3 and 5-10 under 35 USC 102(b) as being anticipated by Rasche et al. ("ECG-gated 3D-rotational coronary angiography (3DRCA)", 2002, Proceedings of the 16th International Congress and Exposition on Computer Assisted Radiology and Surgery (CARS 2002), pages 827-831; henceforth "Rasche").

Independent Claims 1 and 8 have been amended to more particularly point out that which Applicants regard as their invention. In particular, the reconstruction is now explicitly stated to include the determination of "projection lines ($l_{i-1}, l_i, l_{i+1}, l_j, l_k, l_l$) of a characteristic object feature", which is neither taught nor suggested by Rasche. The reconstruction is further recited to use for the reconstruction "only those projection pictures . . . for which the projection lines . . . of the characteristic object feature intersect approximately at a common spatial point". Additionally, the recited reconstruction omits "those projection pictures . . . having projection lines . . . of the characteristic object feature that do not intersect at approximately the same spatial point".

As described in the Specification, Applicants acknowledge that it is known to "[record] the electrocardiogram (ECG) in parallel to the X-rays and then [use] for reconstruction of the three-dimensional image only those X-ray pictures which correspond to approximately the same ECG phase." Rasche similarly uses a "gating window" in an image reconstruction to temporally resolve an impression of a coronary artery tree. Also as stated in the current Specification, "it appears that furthermore

certain inaccuracies and artifacts can occur in the reconstructed image". It will be understood by one of skill in the art that temporal (i.e., electrical) resolution and spatial resolution are not necessarily commensurate, even with cyclically moving objects. In the case of cardiac motion, for example, a heart may be in the same ECG phase from cycle to cycle, but not necessarily be in the same physical orientation and position. As an example of causes for such movement, other forces can be acting on the heart to cause movement, such as, for example, lung movement, blood pressure change, etc.

Therefore, although Rasche displays, in the words of the Examiner, "at least during diastole phase a clear visualization of the coronary artery tree", such a clear visualization may not be obtained if the heart has in fact moved.

The device and method recited in Claims 1 and 8 overcome this problem of inaccuracies and artifacts by eliminating the need to correlate images with data obtained by another measuring device, such as ECG data. The present device and method determine projection lines that establish a common physical reference point to which additional projection pictures can be related. These selected projection pictures can then be used to perform a reconstruction to yield a three-dimensional image, having eliminated from the reconstruction those projection pictures wherein the imaged object is in a different orientation and position, based upon their projection lines failing to intersect the common spatial point.

Rasche lacks at least the determination of projection lines as recited, selection of projection pictures based upon projection lines intersecting a common reference point, and filtering out projection pictures that do not meet the projection line intersection

criterion, in order to produce a more accurate reconstructed image based upon spatial data rather than temporal/electrical data.

Thus independent Claims 1 and 8, as well as Claims 2, 3, 5-7, 9, and 10 dependent therefrom, directly or indirectly, are not anticipated by Rasche.

IV. Rejection of Claim 4 under 35 USC 103(a)

The Examiner has rejected Claim 4 under 35 USC 103(a) as being unpatentable of Rasche, and further in view of Chen et al. ("Quantitative Analysis of Reconstructed 3D Coronary Arterial Tree and Intercoronary Devices", July 2002, IEEE Transactions on Medical Imaging, Vol. 21, No. 7, pages 724-739.

As Claim 4 is dependent from Claim 1, Claim 4 is also believed to patentably define over the cited art.

V. New Claims 11-19

New Claims 11-19 have been added to more particularly point out that which Applicants regard as their invention.

Claim 11, dependent from Claim 2, recites that "the characteristic object feature comprises an object that is at least partially impervious to X rays." Support for this recitation may be found in the Specification at par. [0025] of the published application: "Instead of a vascular branch a marker can be used as an object feature such as for example a position marker impervious to X-rays on a catheter."

Claim 12, dependent from Claim 4, contains the recitations deleted from Claim 4 as originally filed.

Claim 13, dependent from Claim 5, contains the recitations deleted from Claim 5 as originally filed.

Claim 14, dependent from Claim 6, provides an angular range of 70° to 110° between the projection directions of the first and second projection pictures. Support for this recitation may be found in the Specification at par. [0014] of the published application: "In particular it [the angle] can lie in an angular range between 70° and 110°".

Claim 15, dependent from Claim 9, recites that the arc extends over a range greater than or equal to 180°. Support for this recitation may be found in the Specification at par. [0017]: "Typically the circle arc extends over a range of about 180° in order to cover all independent projection directions." Also, at par. [0025]: "The project centers . . . are distributed on a curve . . . which in the optimum case covers an angle of more than 210°."

Independent Claim 16 is directed to a "system for generating a three-dimensional image of a cyclically moving object from a plurality of projection pictures of the object collected from a plurality of different projection directions". The system includes a processor (data processing device 7 in FIG. 1) that is programmed to receive data representative of at least some of the plurality of projection pictures and select a first projection picture from among the plurality of projection pictures. This element finds support in Claim 6 as originally filed.

The processor is also programmed to identify a first projection line from a source in a first position through a located object feature to the first projection picture and to identify a second projection picture from among the plurality of projection pictures having a second projection line from the source in a second position through the object feature to the second projection picture. These elements find support in Claim 6 as originally filed.

The processor is further programmed to use at least some of the projection pictures having projection lines extending through the object feature to generate a three-dimensional image of the object. The image is generated omitting data from those projection pictures having projection lines that do not intersect the object feature. This element finds support in Claims 1 and 6 as originally filed.

Claim 16 patentably defines over the cited art for at least similar reasons to those put forth above in reference to Claims 1 and 8, namely, the determination of projection lines, selection of projection pictures based upon projection lines intersecting a common reference point, and filtering out projection pictures that do not meet the projection line intersection criterion, in order to produce a more accurate reconstructed image based upon spatial data rather than temporal/electrical data.

Claim 17, dependent from Claim 16, recites the transmission of the generated three-dimensional image to a display, which finds support in FIG. 1, reference numeral 8, referring to a monitor.

Claims 18 and 19, dependent from Claim 16, recite that the object feature can be located either by means of image processing or from a user. Support for this feature

may be found in the Specification at par. [0012] in the published application: “The characteristic object feature can in particular be located by a method of automatic image processing or interactively by a user”.

New Claims 11-19 are believed to patentably define over the cited art, and have been presented with no new matter having been added.

VI. Additional Claim Amendments

Additional amendments have been made to conform the claims to U.S. practice. In particular, reference numerals have been removed from Claims 1-3, 6, 9, and 10. Method Claim 8 has been recast using the recommended gerund (-ing) verb forms. European-style language such as “characterized in that” has been amended to “wherein” and “further comprising” recitations in Claims 2-5, 7, 9, and 10. Additional non-substantive grammatical corrections have also been made in Claims 1 and 8, and “is” substituted for “comprises” in Claims 4 and 5. The word “approximately” has been added to Claim 9 so as to avoid undue limitation.

Conclusions

Applicants respectfully submit that the above amendments place this application in a condition for allowance, and passage to issue is respectfully solicited. Applicants and the undersigned would like to again thank the Examiner for his efforts in the examination of this application and for reconsideration of the claims as amended in light of the arguments presented.

Respectfully submitted,



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